



National Aeronautics and Space Administration

# Ares V: Overview and Status

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**IAC 2009**  
October 12-16, 2009





# Introduction

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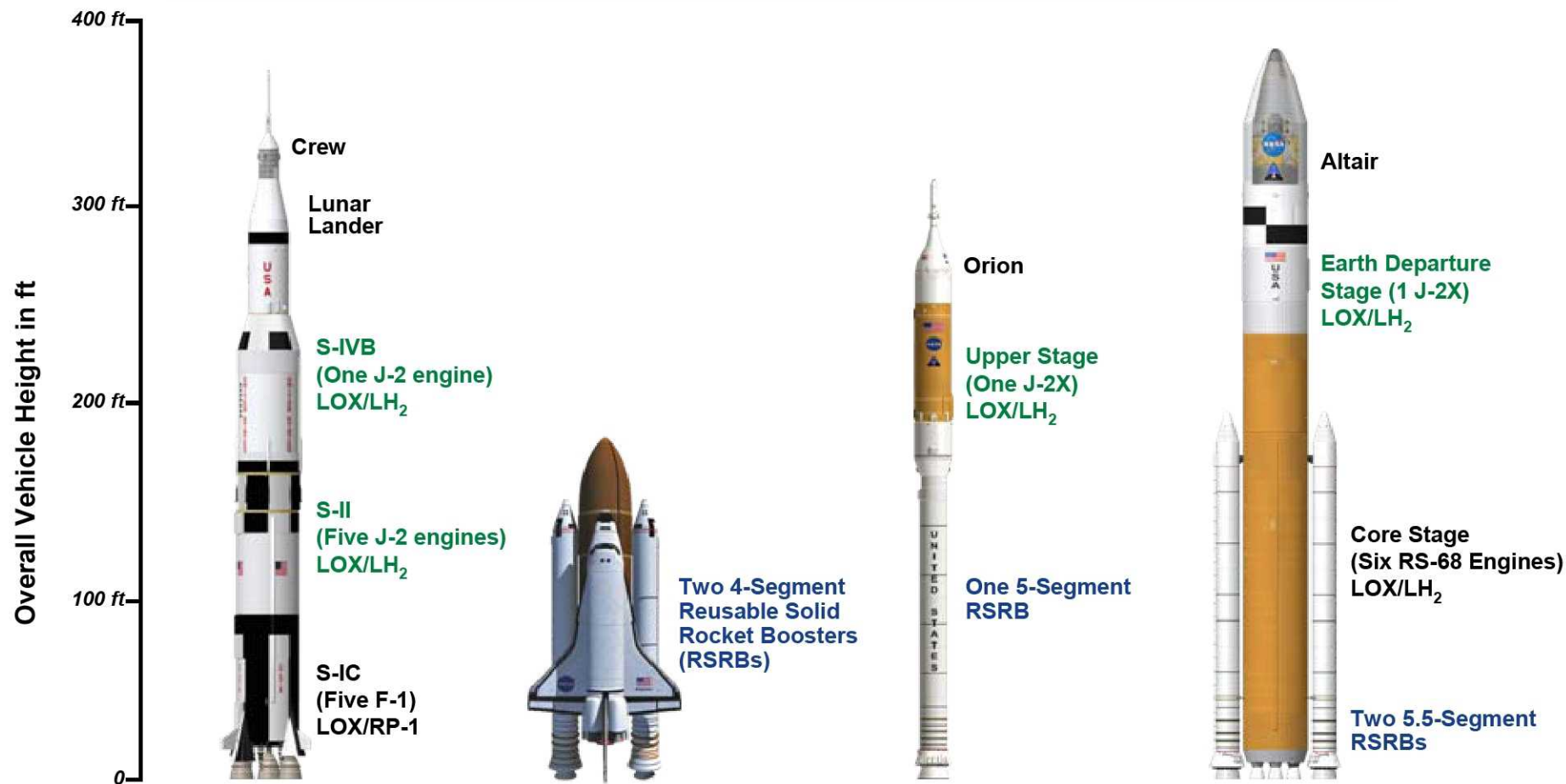


- ◆ **The NASA Ares Projects Office is developing the launch vehicles to move the United States and humanity beyond low earth orbit**
- ◆ **Ares I is a crewed vehicle, and Ares V is a heavy lift vehicle being designed to launch cargo into LEO and transfer cargo and crews to the Moon**
- ◆ **This is a snapshot of development. Ares V is early in the requirements formulation stage of development pending the outcome of the Review of U.S. Human Space Flight Plans Committee and White House action**
- ◆ **Via commonality and proven hardware, Ares V design benefits from work well under way on the Ares V**
- ◆ **My goal today is to update you on the status of the Ares V vehicle**



# Building on 50 Years of Proven Experience

## – Launch Vehicle Comparisons –



**Saturn V: 1967–1972**

**Space Shuttle: 1981–Present**

**Ares I: First Flight 2015**

**Ares V: First Flight 2018**

Height	360 ft	184.2 ft	325.0 ft	381.1 ft
Gross Liftoff Mass (GLOM)	2,948.4 mT (6,500K lbm)	2,041.1 mT (4,500.0K lbm)	933.2 mT (2,057.3K lbm)	3,704.5 mT (8,167.1K lbm)
Payload Capability	99.0K lbm to TLI 262.0K lbm to LEO	55.1K lbm to LEO	54.9K lbm to LEO	156.7K lbm to TLI with Ares I 413.8K lbm to LEO

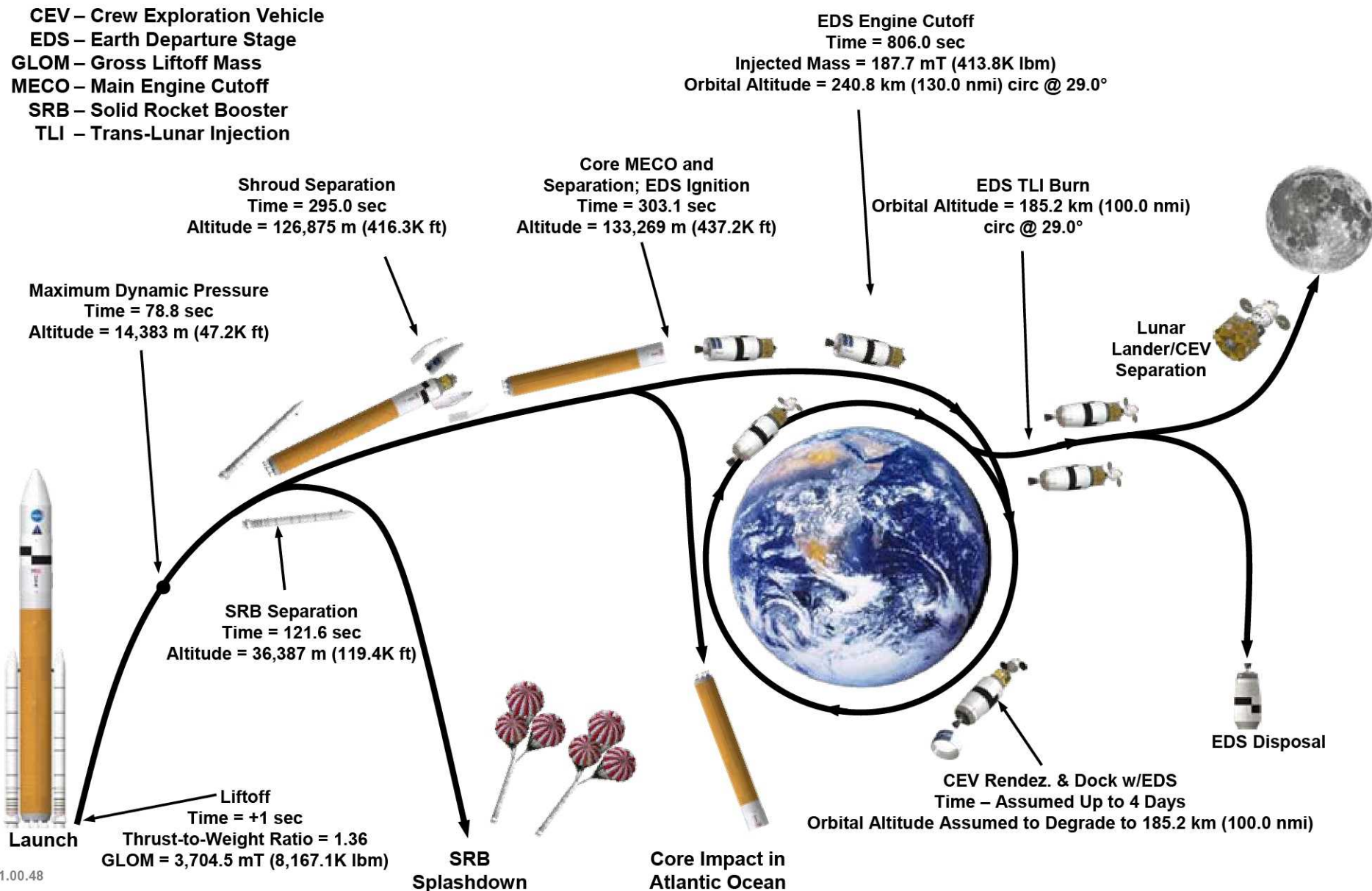




# Ares V Lunar Sortie Mission Profile

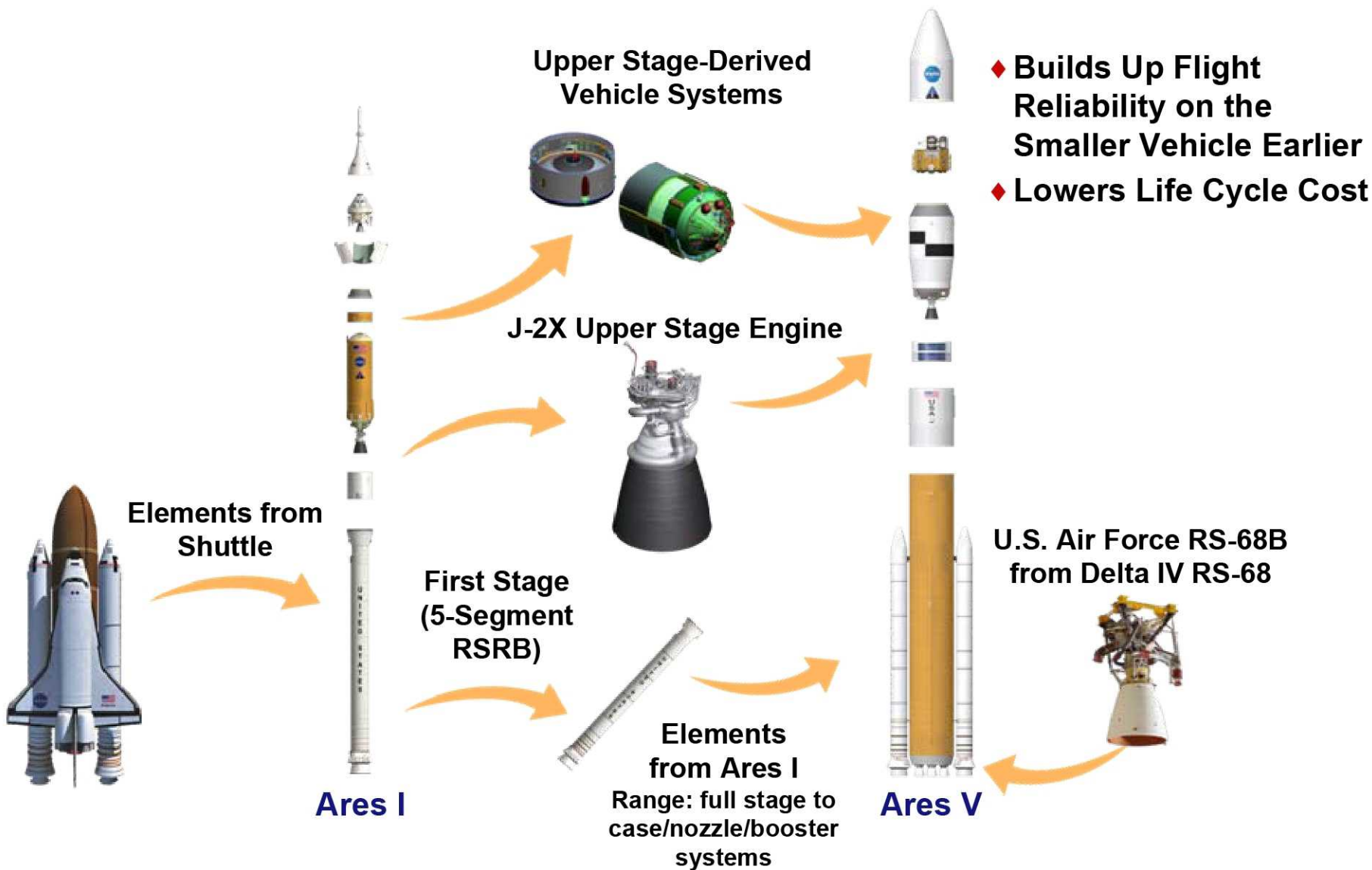


CEV – Crew Exploration Vehicle  
EDS – Earth Departure Stage  
GLOM – Gross Liftoff Mass  
MECO – Main Engine Cutoff  
SRB – Solid Rocket Booster  
TLI – Trans-Lunar Injection





# Ares I and Ares V Commonality





# Ares V Key Requirements



LUNAR SORTIE MISSION			
CARD Requirement	Mass (t)	Mass (lb <sub>m</sub> )	Derived Performance Rqt.
Orion [CA4139]	20.2	44,500	
Crewed Lander [CA0836]	45.0	99,208	
Total TLI [CA0848]	66.9	147,575	Derived TLI > 66.9 t
	45.0	99,208	Derived ETO > 45.0 t

- ♦ ETO Mission Destination: 130 nmi, 29°
- ♦ Loiter Duration: 4 days (CARD TBD)
- ♦ TLI Maneuver Starting Conditions: 100 nmi, 29°
- ♦ TLI  $\Delta V$  = 3175 m/s + Gravity Loss

LUNAR CARGO MISSION			
CARD Requirement	Mass (t)	Mass (lb <sub>m</sub> )	Derived Performance Rqt.
Cargo Lander [CA5231]	53.6	118,168	
Total TLI [CA0847]	54.6	120,372	Derived TLI > 54.6 t
Total ETO Goal [CA0847]	54.6	120,372	Derived ETO > 54.6 t

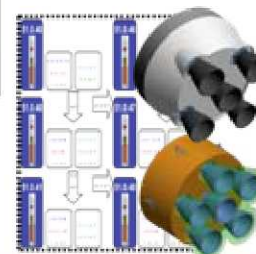
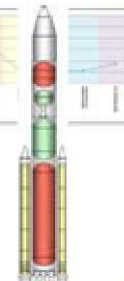
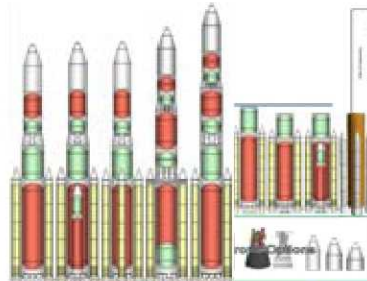
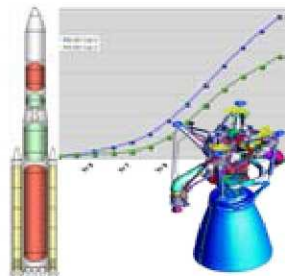
- ♦ ETO Mission Destination: Phasing Orbit
- ♦ Loiter Duration: None (no loiter capability on EDS)
- ♦ Note that Saturn V TLI payload capability was 48.6 t (Apollo 17 - CM/SM/ LM/SLA) and
- ♦ Ares V Earth-to-TLI requirement exceeds Saturn V Capability by 31%

***LCCR focus is to determine driving requirements and establish appropriate performance margin***





# Exploration Systems Architecture Study (ESAS) (2005) to Lunar Capability Concept Review (LCCR) (2008) Design Milestones



## Original ESAS Capability

- 45.0 mT Lander
- 20.0 mT CEV
- No Loiter in LEO
- 8.4 m OML
- 5 SSMEs / 2 J2s

## CY-06 Budget Trade to Increase

- Ares I / Ares V Commonality
- Ares I: 5-Seg RSRB / J-2X instead of Air-Start SSME
- Ares V: 1 J-2X

## Detailed Cost Trade of SSME vs. RS-68

- ~\$4.25B Life Cycle Cost Savings
- 5 Engine Core
- Increased Commonality with Ares I Booster
- 30–95 Day LEO Loiter Assessed

## IDAC-3 Trade Space

- Lunar Architecture Team 1/2 (LAT) Studies
- Mission Delta V's increased
- Increase Margins From TLI Only to Earth through TLI
- Loiter Penalties for 30-Day Orbit Quantified

## EDS Diameter Change from 8.4m to 10m

- Lunar Architecture Team 1/2 (LAT) Studies
- Lunar/Mars Systems Benefits
- Tank Assembly Tooling Commonality

## Incorporate Ares I Design Lessons Learned/Parameters

- Core Engine / SRB Trades to Increase Design Margins
- Increase Subsystem Mass Growth Allowance (MGA)

## Recommended Option

- 6 Core Engines
- 5.5-Segment PBAN
- Updated Capability
- 45.0 t Lander
- 20.2 t CEV
- ~6 t Perf. Margin
- 4-Day LEO Loiter
- Ares I Common MGAs
- Booster Decision Summer 2010

220 Concepts Evaluated

320 Concepts Evaluated

730 Concepts Evaluated

460 Concepts Evaluated

2005

2006

2007

2008

Ares I ATP

Orion ATP

Ares I SRR

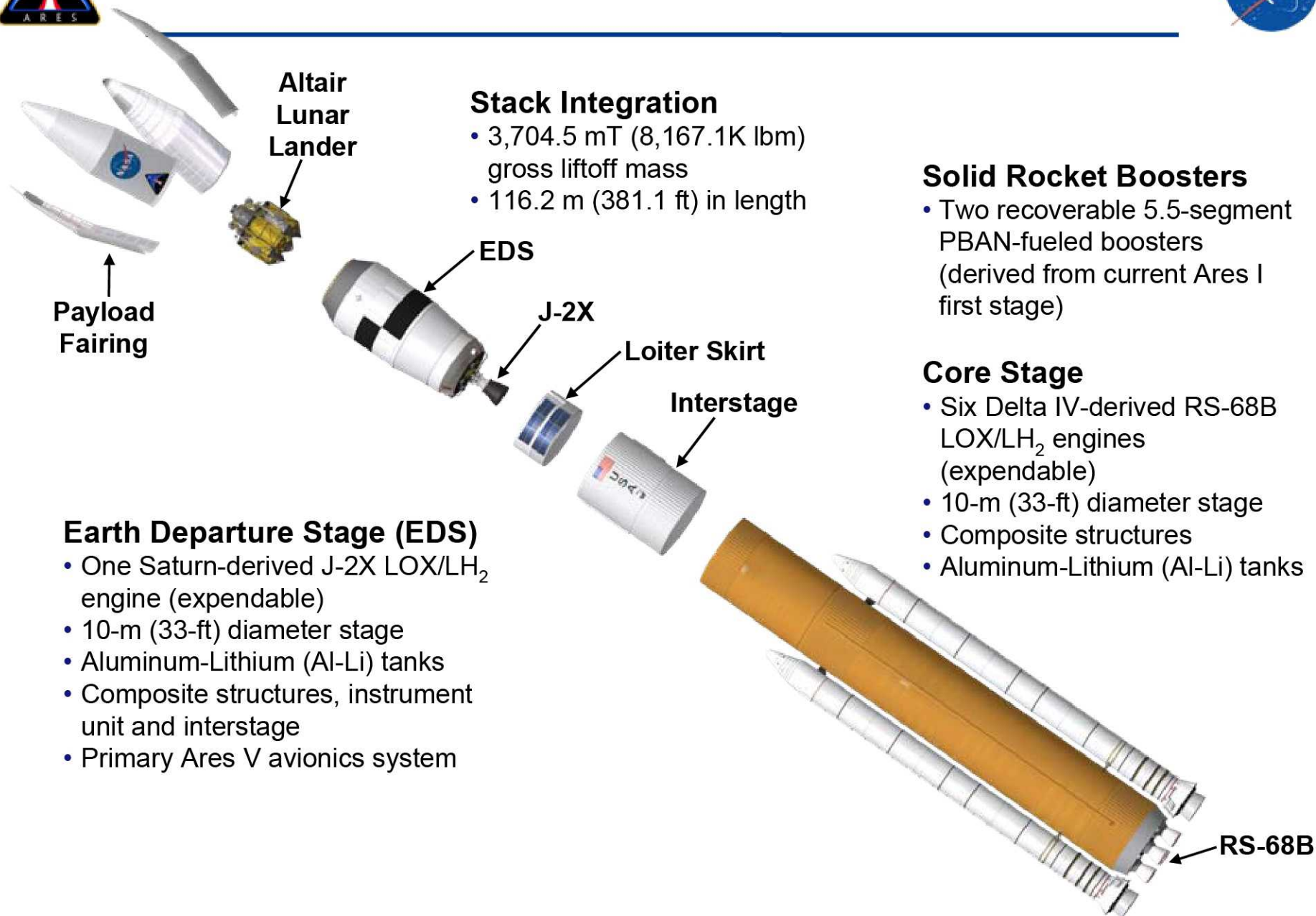
Orion SRR

Ares I SDR

Ares V MCR



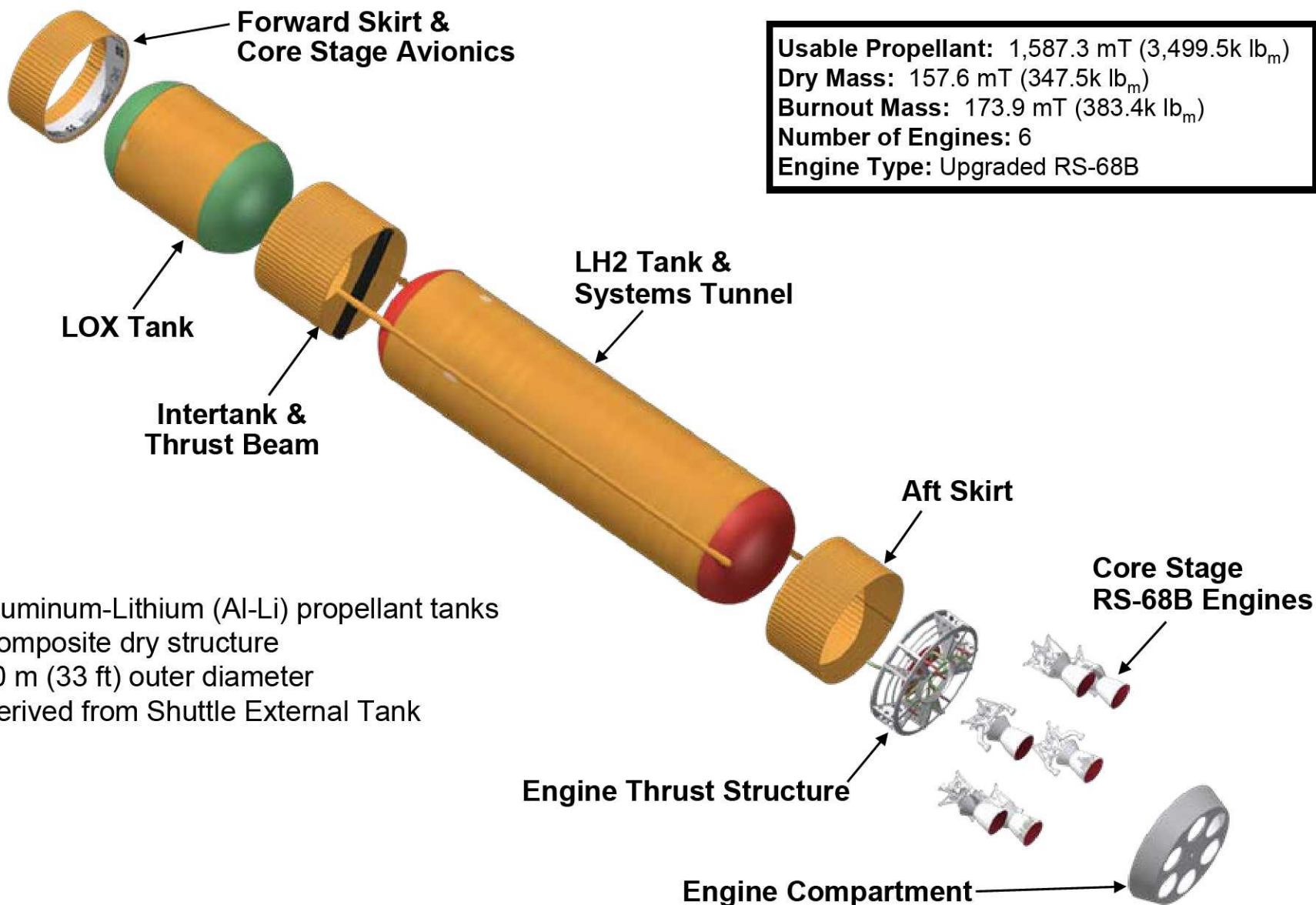
# Ares V Elements







# Ares V Core Stage





# RS-68 to RS-68B



- \* Redesigned turbine nozzles to increase maximum power level by  $\approx 2\%$

Redesigned turbine seals to significantly reduce helium usage for pre-launch

- ◆ Other RS-68A upgrades or changes that may be included:

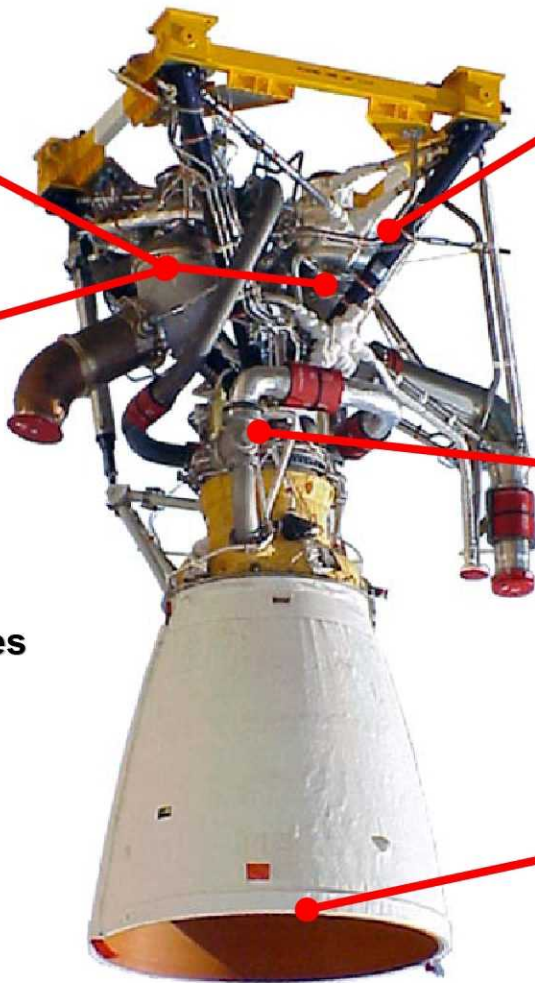
- Bearing material change
- New Gas Generator igniter design
- Improved Oxidizer Turbo Pump temp sensor
- Improved hot gas sensor
- 2<sup>nd</sup> stage Fuel Turbo Pump blisk crack mitigation
- Cavitation suppression
- ECU parts upgrade

Helium spin-start duct redesign, along with start sequence modifications, to help minimize pre-ignition free hydrogen

- \* Higher element density main injector improving specific impulse by  $\approx 2\%$  and thrust by  $\approx 4\%$

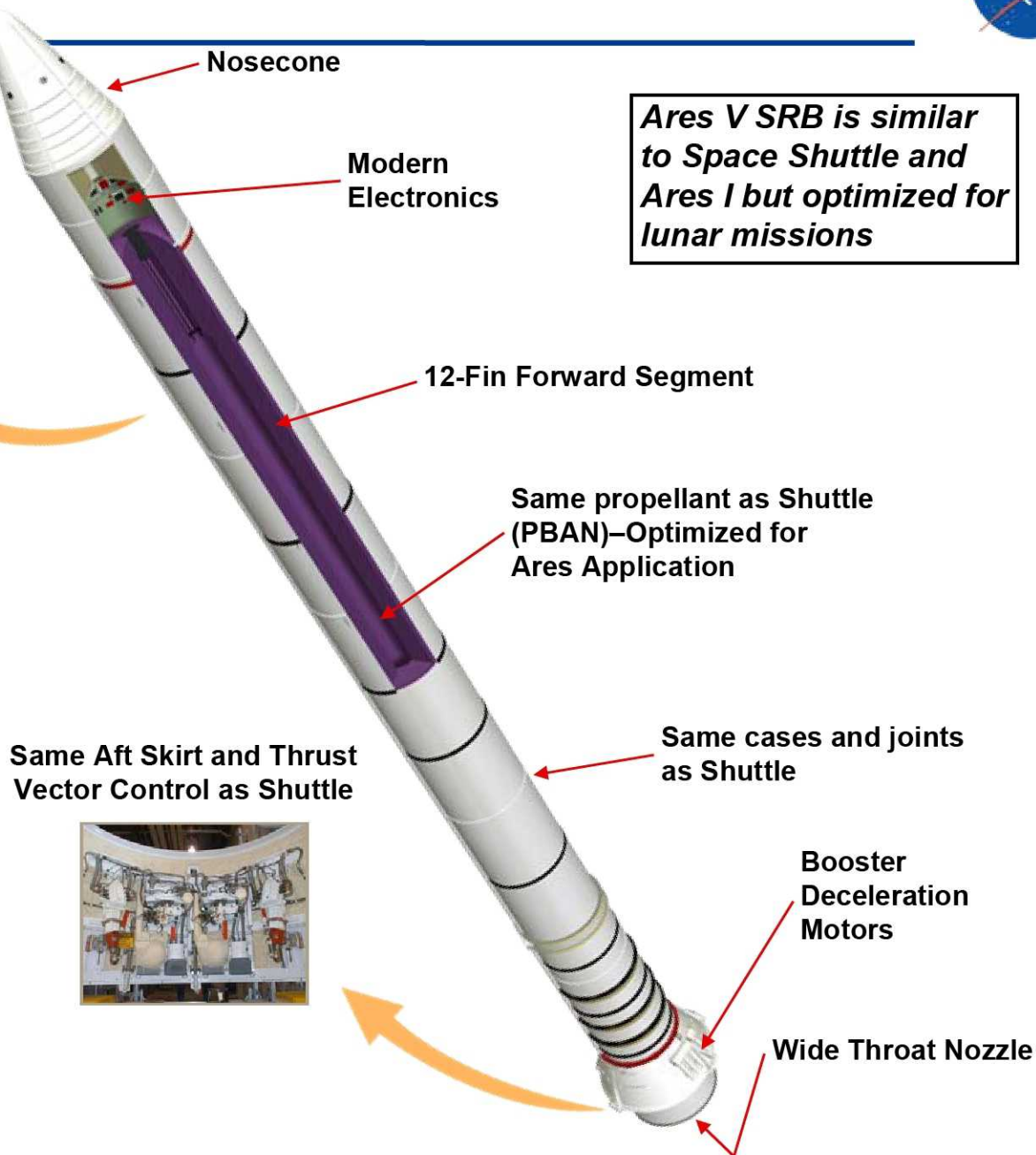
Increased duration capability ablative nozzle

- \* RS-68A Upgrades





# Ares V Solid Rocket Booster (SRB)



## Each Booster:

**Mass:** 791.5 t (1,744.9 klb<sub>m</sub>)

**Thrust:** 16.86 MN (3.79 Mlb<sub>f</sub>)

**Burn Duration:** 126 sec

**Height:** 59 m (193 ft)

**Diameter:** 3.7 m (12 ft)







# DM-1 in T-97 Test Stand

Promontory, UT





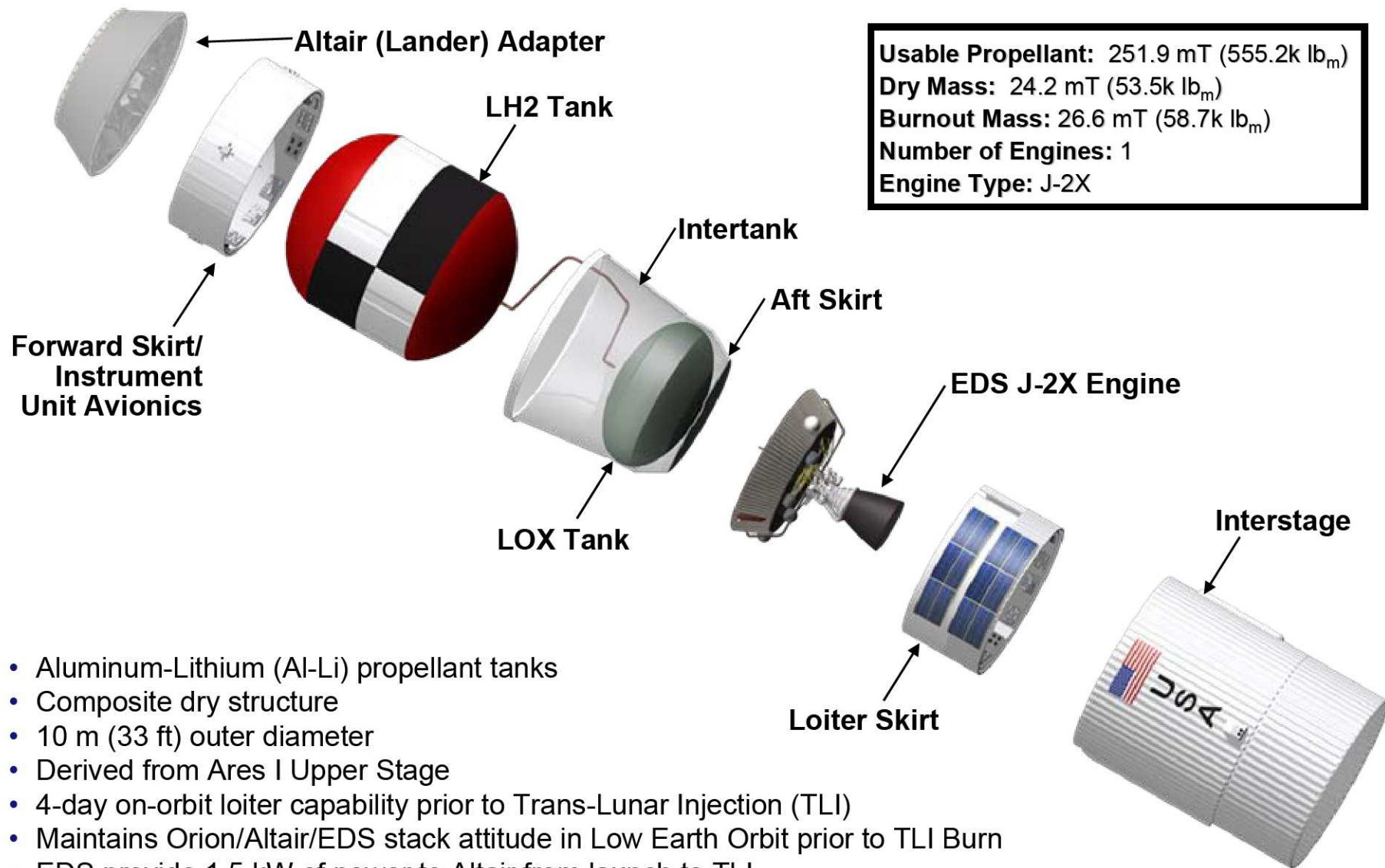
# Ares I-X First Stage Accomplishments







# Ares V Earth Departure Stage



- Aluminum-Lithium (Al-Li) propellant tanks
- Composite dry structure
- 10 m (33 ft) outer diameter
- Derived from Ares I Upper Stage
- 4-day on-orbit loiter capability prior to Trans-Lunar Injection (TLI)
- Maintains Orion/Altair/EDS stack attitude in Low Earth Orbit prior to TLI Burn
- EDS provide 1.5 kW of power to Altair from launch to TLI





# Upper Stage Accomplishments



**Manufacturing Demonstration Article Full Dome Weld**  
Marshall Space Flight Center, AL



**Ares Vertical Milling Machine Development**  
Chicago, IL



**Roll Control Thruster Hot-Fire Testing**  
Sacramento, CA



**Al-Li Orthogrid Panel Buckling Testing**  
Marshall Space Flight Center, AL



# J-2X Engine

## *Used on Ares I and Ares V*



### Turbomachinery

- Based on J-2S MK-29 design

### Gas Generator

- Based on RS-68 design

### Engine Controller

- Based directly on RS-68 design and software architecture

### Regeneratively Cooled Nozzle Section

- Based on long history of RS-27 success

### Flexible Inlet Ducts

- Based on J-2 & J-2S ducts

### Open-Loop Pneumatic Control

- Similar to J-2

### HIP-bonded MCC

- Based on RS-68 demonstrated technology

### Metallic Nozzle Extension

- New design

**Mass:** 2.5 mT (5,511 lbm)

**Height:** 4.7 m (15.4 ft)

**Diameter:** 3.05 m (10 ft)

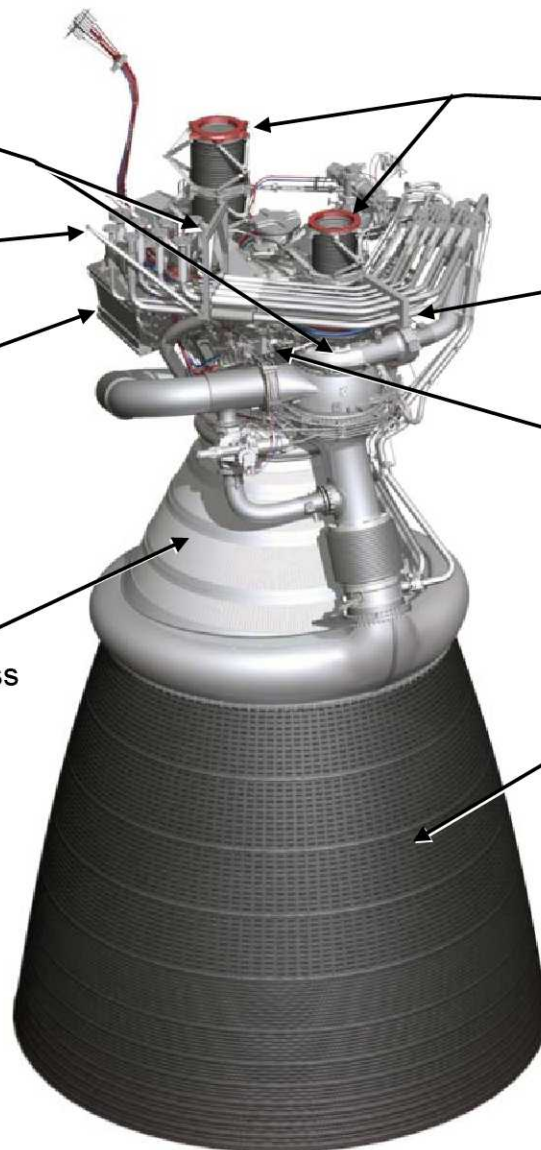
**Thrust:** 1,308K N (294K lbm) (vac)

**Isp:** 448 sec (vac)

**Operation Time:** 500 sec.

**Altitude Start / On-orbit Restart**

**Operational Life:** 8 starts/ 2,600 sec



**Pratt & Whitney**

A United Technologies Company

**Pratt & Whitney Rocketdyne, Inc.**





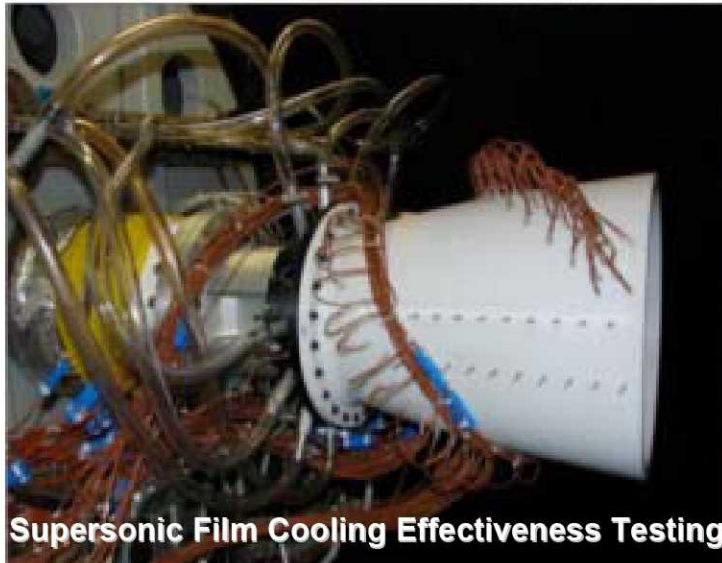
# J-2X Upper Stage Engine Progress



**OTP Shaft and First Stage Blisk**



**Nozzle Turbine Exhaust Manifold Base Ring Forging**



**Supersonic Film Cooling Effectiveness Testing**



**Workhorse Gas Generator/Turbine Simulator Testing**





# Test Facilities Progress: A-3 Stand Construction





# Payload Shroud Point Of Departure



**Point of Departure  
(Biconic)**

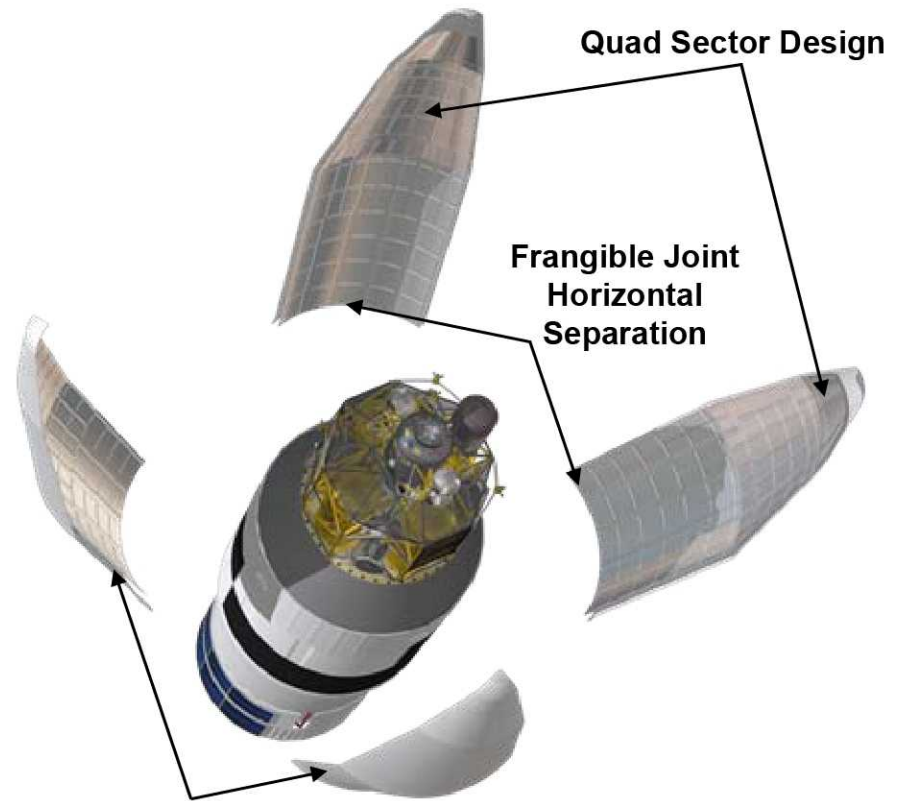


**Leading Candidate  
(Ogive)**



- Composite sandwich construction (Carbon-Epoxy face sheets, Al honeycomb core)
- Painted cork TPS bonded to outer face sheet with RTV
- Payload access ports for maintenance, payload consumables and environmental control (while on ground)

**Mass:** 9.1 mT (20.0k lbm)  
**POD Geometry:** Biconic  
**Design:** Quad sector  
**Barrel Diameter:** 10 m (33 ft)  
**Barrel Length:** 9.7 m (32 ft)  
**Total Length:** 22 m (72ft)



**Thrust Rail Vertical Separation System  
Payload umbilical separation**





# Current Activities



- ◆ Ares V concept definition/requirements development industry proposals
- ◆ Structural test approach
- ◆ Structural test articles
- ◆ Ares V-Y flight test objectives
- ◆ Ares V aerodynamic characterization
- ◆ Manufacturing, test, and launch facilities
- ◆ Core Stage and EDS propulsion test approach and facilities assessment
- ◆ Technology prioritization
- ◆ Ares V Cost threat risk assessment
- ◆ Ares V performance risk assessment

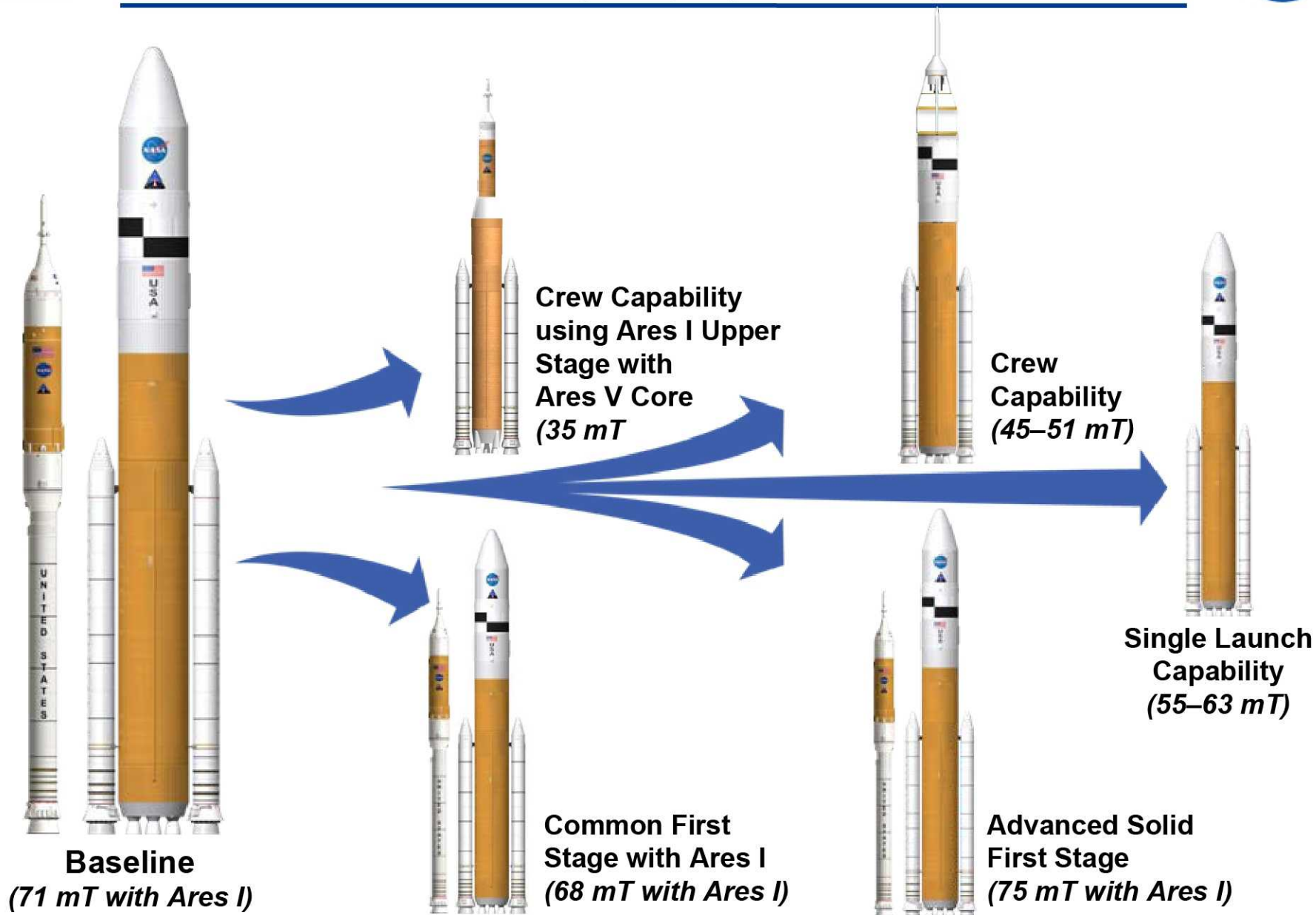






# Range of Architecture Options Enabled

*A Few Examples (Payload to TLI)*





# Ares V Summary



- ◆ **NASA has begun preliminary concept work on the vehicle. Over 1,700 alternatives have been investigated since ESAS**
- ◆ **Focused on design of EDS, payload shroud, core stage, and RS-68 core stage engines**
- ◆ **Recent point of departure update was made following the Lunar Capability Concept Review**
  - Adds additional performance margin using an additional RS-68
  - Adds half segment on the first stage boosters
- ◆ **Shroud size is dictated by eventual size of Altair lunar lander**
- ◆ **Also investigating alternate uses for Ares V not related to human space exploration**
  - Astronomy applications (e.g., large aperture telescopes)
  - Deep space missions
  - DoD applications
  - Other applications





[www.nasa.gov/ares](http://www.nasa.gov/ares)